International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Climate Change & Its Effects on Ecosystems & Food Security in India

Mr. Jawale Gautam Ramchandra

Assistant Professor, P.D.Karkhanis College of Arts & Commerce, Ambernath East, Dist Thane, Maharashtra

Abstract:
Climate change is reshaping India's climate, ecosystems, and food systems. Rising temperatures, shifting monsoon patterns, increased frequency of extreme events (heatwaves, droughts, and floods), and land-use change together threaten biodiversity, degrade ecosystems, and create new risks for agricultural production and food security. This paper reviews observed trends and recent statistics, synthesizes evidence on impacts to ecosystems and food security, and outlines policy responses and adaptation/mitigation measures. The analysis draws on national datasets (IMD, Forest Survey of India), international assessments (IPCC, FAO), and recent peer-reviewed literature to present an integrated view and practical recommendations for policymakers and stakeholders.

1. Introduction

India is one of the world's most climate-vulnerable countries: a large, climatically diverse landmass dependent on seasonal monsoons for agriculture and with millions dependent on natural resources for livelihoods. The interaction between climatic shifts and socioeconomic pressures (population growth, land-use change, and resource extraction) amplifies risks to ecosystems and food systems. This paper focuses on: (1) observed climate trends in India; (2) ecological responses and ecosystem vulnerability; (3) implications for food security (production, access, utilization, and stability); and (4) adaptation and policy pathways.

2. Data and Methods

This is a synthesis paper using national reports and peer-reviewed literature. Key data sources include the India Meteorological Department (IMD) climate statements, India State of Forest Report (FSI/ISFR), national policy documents (NAPCC; National Action Plan on Food Security & Climate Change), FAO and IPCC assessments, and recent scientific studies. Where possible, national summary statistics are presented in tables to show trends and to ground the discussion in measurable indicators.

3. Observed Climate Trends in India

Table 1 summarizes headline climate indicators and recent observations for India.

Table 1 — Selected observed climate indicators for India

Indicator	Value / Trend
Long-term (1901–2020) mean temperature trend	+0.62 °C per 100 years (country average)

Recent annual mean (2024)	25.75 °C; ~+0.65 °C above 1991–2020 baseline
Frequency of extreme heat and heatwave days	Strong increase in warmest years; clustering of top warm years since 2006
Monsoon variability	Increased internal variability and changing intra-seasonal distribution; more extreme rainfall events

Sources:

- IMD statement (1901–2020)
- IMD (2024 statement)
- IMD / IPCC
- IPCC, IMD

Above trends reflect both long-term warming and accelerating recent warming with increases in extreme heat days and more intense rainfall events. The pattern of warming is not uniform; north-western India and higher elevations are showing pronounced changes in temperature extremes.

4. Ecosystem Impacts

4.1 Forests, vegetation and land cover:

India's forest and tree cover assessment (ISFR 2021) reports a total forest & tree cover of approximately **80.9 million hectares** (about 24.6% of geographic area) with a net increase in forest and tree cover area reported between assessments. However, regional declines (for example in certain north-eastern zones) and rising incidence of forest fires, pest outbreaks, and drought-induced tree mortality are creating new vulnerabilities for forest ecosystems.

4.2 Coastal and marine ecosystems:

Sea-level rise, increasing sea surface temperatures, and intensified cyclones threaten coastal habitats including mangroves, estuaries, and coral reefs. Mangrove extent has shown modest gains in some assessments thanks to conservation, but coastal erosion and salinization of soils are increasing risks to coastal livelihoods and agriculture.

4.3 Freshwater ecosystems:

Glacial retreat in the Himalaya, altered river flow timing, and changes in monsoon intensity affect freshwater availability, riverine biodiversity, and inland fisheries. Increased water temperatures and altered flow regimes also reduce oxygen levels and change species composition.

4.4 Biodiversity and species shifts

Phonological shifts (earlier flowering, altered migration timings), range shifts of species to higher altitudes/latitudes, invasive species expansion, and localized extinctions have been documented in multiple ecosystems. These changes have cascading effects on ecosystem services such as pollination, pest control, and water purification — all of which underpin agricultural productivity.

5. Food Security: Observed Status & Climate Links

Food security in India is multifaceted — it includes availability, access, utilization (nutrition), and stability. Table 2 summarizes key national indicators relevant to food security and agriculture.

Table 2 — Selected food-system indicators (India)

Indicator	Recent value / estimate
Share of population dependent on agriculture for livelihood	~42–46% (varies by source and year)
Agriculture & allied share of GDP (2023-24)	~16–18% (approx.)
Prevalence of undernourishment (PoU)	~13.7% (2021–23 SOFI estimate)
Global Hunger Index (GHI) 2024 score	27.3 (rank ~105/127; 'serious')

Sources:

- Economic Survey / PLFS analyses
- Economic Survey / Government releases
- FAO / SOFI 2024
- GHI 2024

In the above table it is shown that Despite improvements in aggregate food availability, malnutrition (child stunting, wasting) and localized food insecurity persist. Climate risks threaten both productivity and the stability of supply and incomes, especially for smallholders.

5.1 Agricultural production and yields

Observational and modelling studies indicate that heat stress, altered rainfall patterns, and extreme events already cause year-to-year yield variability in staples (rice, wheat, pulses). Ground-level effects include reduced grain filling under heat stress, increased pest and disease pressure, and water stress during critical crop stages. Fisheries and livestock face climate-related stresses through changes in water availability, pasture quality, and heat-related mortality.

5.2 Food access and livelihoods

Losses due to crop failure, higher food price volatility following climatic extremes, and damage to rural infrastructure reduce household incomes and access to food. Women, landless labourers, and marginalized communities are disproportionately affected due to limited assets and adaptive capacity.

6. Case Examples of Climate–Food Linkages

- **Heatwaves and wheat production:** High-temperature episodes during terminal grain filling reduce wheat yields and quality. Repeated heat events increase reliance on irrigation and raise production costs.
- **Erratic monsoon and rice/maize:** Short-duration intense rainfall can cause waterlogging and reduce yields, while delayed monsoon onset or dry spells increase irrigation demand and risk crop failure.
- **Forest fires and ecosystem services:** Increased forest fires reduce carbon sequestration potential and pollinator habitats, indirectly affecting crop pollination and productivity.

7. Adaptation and Policy Responses

India's policy framework includes national programmes and action plans addressing climate, land restoration, and food security. Key elements include:

- **National Action Plan on Climate Change (NAPCC)** and associated missions addressing mitigation and adaptation.
- **National Action Plan on Food Security & Climate Change** (recent policy guidance emphasizing adaptive agriculture, crop insurance, and nutrition-sensitive planning).
- **State-level climate action** and watershed, agroforestry, and irrigation programs to build resilience.

- **Forest restoration and mangrove conservation** (e.g., targeted restoration goals under the national land/forest policies).

7.1 Agricultural adaptation measures

Practical measures to reduce vulnerability include: climate-resilient crop varieties (heat/drought tolerant), improved cropping calendars and agro-meteorological advisories, expansion of micro-irrigation, diversification into climate-resilient crops and allied activities (livestock, horticulture, fisheries), soil-health improvements (organic matter, conservation agriculture), and insurance / social protection.

7.2 Ecosystem-based adaptation

Restoring and conserving natural ecosystems (wetlands, mangroves, forests) provides multiple benefits: buffer against extremes, habitat for pollinators and fish nurseries, carbon sequestration, and livelihood support.

8. Conclusion

Climate change is not the only driver of ecosystem change and food insecurity in India — land-use change, pollution, demographic pressures, and governance challenges interact with climate to determine outcomes. Nonetheless, warming and extremes amplify existing vulnerabilities. The political economy of adaptation — ensuring smallholder access to technology, finance, and market linkages — will determine whether India can maintain food security while meeting development goals.

Key challenges include:

- Geographic heterogeneity: impacts and adaptation needs differ widely across agro-ecological zones (Indo-Gangetic plains, rainfed Deccan, Himalaya, coasts).
- Equity: marginalized groups require targeted measures (social protection, access to credit, gender-sensitive programming).
- Data and monitoring gaps: localized, high-resolution climate–crop impact data are needed to tailor interventions.

9. Recommendations

1. **Scale up climate-smart agriculture nationally:** accelerate dissemination of climate-resilient seeds, efficient irrigation, and agro ecological practices.
2. **Strengthen early-warning and agro-meteorological advisory systems** to reach smallholders in local languages and formats.
3. **Invest in ecosystem restoration** (mangrove, wetland, forest restoration) as nature-based solutions that protect coasts and sustain fisheries.
4. **Expand social protection and adaptive finance** (index insurance, targeted cash transfers) to buffer households against shocks.
5. **Promote diversified livelihoods** that reduce overdependence on climate-sensitive cropping and integrate value chains and storage/infrastructure.
6. **Improve monitoring and research**: local climate-crop impact studies, integrated ecosystem services accounting, and monitoring of biodiversity indicators.

References:

1. IMD statement (1901–2020)
2. IMD (2024 statement)

3. IMD / IPCC
4. IPCC, IMD
5. Economic Survey / PLFS, Government of India
6. Forest Survey of India
7. FAO / SOFI 2024
8. GHI 2024